IN THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (Original) A diffraction grating element, comprising:

given a first plane and a second plane parallel with each other, a first medium (index of refraction n_1) provided at the outer side than the first plane being in contact with the first plane,

a second medium (index of refraction n_2) and a third medium (index of refraction n_3, $n_3<n_2$) disposed alternately in a predetermined direction parallel with the first plane between the first plane and the second plane being in contact with the first plane and the second plane to constitute a diffraction grating, and

a fourth medium (index of refraction n_4) provided at the outer side than the second plane being in contact with the second plane, wherein

each of the indexes of refraction n_1-n_4 of the first medium, the second medium, the third medium and the fourth medium satisfies a relational expression of "$n_3<n_1<n_2$, $n_3\leq n_4\leq n_2$", or "$n_3\leq n_1\leq n_2$, $n_3<n_4<n_2$", and

both of the second medium and the third medium are solid.

2. (Original) The diffraction grating element according to claim 1, wherein, given that an average index of refraction between the first plane and the second plane is n_{av}, the index of refraction n_1 of the first medium satisfies a relational expression of "n_{av}-$0.2\leq n_1\leq n_{av}+0.2$".

3. (Original) The diffraction grating element according to claim 2, wherein the index of refraction n_4 of the fourth medium satisfies a relational expression of "n_{av}-$0.2\leq n_4\leq n_{av}+0.2$".

4. (Original) The diffraction grating element according to claim 1, wherein the thickness of the first medium with respect to the direction perpendicular to the first plane is 5μm

or more.

5. (Original) The diffraction grating element according to claim 4, wherein the thickness of the fourth medium with respect to the direction perpendicular to the first plane is 5μm or more.

6. (Original) The diffraction grating element according to claim 1, wherein a wavelength of light in which each diffraction efficiency of TE polarized light and TM polarized light is 90% or more, is present.

7. (Original) The diffraction grating element according to claim 1, wherein a wavelength of light in which the difference of the diffraction efficiency between TE polarized light and TM polarized light is 5% or less is present.

8. (Original) The diffraction grating element according to claim 1, wherein the difference between the index of refraction n_2 of the second medium and the index of refraction n_3 of the third medium is 0.7 or more.

9. (Original) The diffraction grating element according to claim 1, wherein the second medium or the third medium is made of a predetermined material of which index of refraction changes by an irradiation of energy beam.

10. (Original) The diffraction grating element according to claim 9, wherein the predetermined material is a diamond-like carbon.

11. (Original) The diffraction grating element according to claim 1, wherein the first medium or the fourth medium is made of a predetermined material of which etching rate is slower than that of the second medium or the third medium.

12. (Original) The diffraction grating element according to claim 11, wherein the

predetermined material is any one of Al_2O_3, MgO, Nd_2O_3 and a fluorinated compound.

13. (Original) The diffraction grating element according to claim 11, wherein the second medium or the third medium is any one of TiO_2, Nb_2O_5, Ta_2O_5, SiN, SiO_2, SiO, ZrO_2 and Sb_2O_3.

14. (Original) The diffraction grating element according to claim 1, wherein the second medium and the third medium are in contact with each other.

15. (Original) A diffraction grating element, comprising:

given a first plane and a second plane parallel with each other, a first medium (index of refraction n_1) provided at the outer side than the first plane being in contact with the first plane,

a second medium (index of refraction n_2) and a third medium (index of refraction n_3, $n_3<n_2$) disposed alternately in a predetermined direction parallel with the first plane between the first plane and the second plane being in contact with the first plane and the second plane to constitute a diffraction grating, and

a fourth medium (index of refraction n_4) provided at the outer side than the second plane being in contact with the second plane, wherein

each of the indexes of refraction n_1-n_4 of the first medium, the second medium, the third medium and the fourth medium satisfies a relational expression of "$n_3<n_1<n_2$, $n_3\leq n_4\leq n_2$", or "$n_3\leq n_1\leq n_2$, $n_3<n_4<n_2$", and

the first medium or the fourth medium is made of an isotropic material.

16. (Original) The diffraction grating element according to claim 15, wherein, given that an average index of refraction between the first plane and the second plane is n_{av}, the index of refraction n_1 of the first medium satisfies a relational expression of "n_{av}-$0.2\leq n_1\leq n_{av}+0.2$".

17. (Original) The diffraction grating element according to claim 16, wherein the index of refraction n_4 of the fourth medium satisfies a relational expression of "n_{av}-

$0.2 \leq n_4 \leq n_{av}+0.2$".

18. (Original) The diffraction grating element according to claim 15, wherein the thickness of the first medium with respect to the direction perpendicular to the first plane is 5μm or more.

19. (Original) The diffraction grating element according to claim 18, wherein the thickness of the fourth medium with respect to the direction perpendicular to the first plane is 5μm or more.

20. (Original) The diffraction grating element according to claim 15, wherein a wavelength of light in which each diffraction efficiency of TE polarized light and TM polarized light is 90% or more, is present.

21. (Original) The diffraction grating element according to claim 15, wherein a wavelength of light in which the difference of the diffraction efficiency between TE polarized light and TM polarized light is 5% or less is present.

22. (Original) The diffraction grating element according to claim 15, wherein the difference between the index of refraction n_2 of the second medium and the index of refraction n_3 of the third medium is 0.7 or more.

23. (Original) The diffraction grating element according to claim 22, wherein the second medium is any one of TiO_2, Ta_2O_5 and Nb_2O_5, and the third medium is a gas.

24. (Original) The diffraction grating element according to claim 15, wherein the second medium or the third medium is made of a predetermined material of which index of refraction changes by an irradiation of energy beam.

25. (Original) The diffraction grating element according to claim 24, wherein the

predetermined material is a diamond-like carbon.

26. (Original) The diffraction grating element according to claim 15, wherein the first medium or the fourth medium is made of a predetermined material of which etching rate is slower than that of the second medium or the third medium.

27. (Original) The diffraction grating element according to claim 26, wherein the predetermined material is any one of Al_2O_3, MgO, Nd_2O_3 and a fluorinated compound.

28. (Original) The diffraction grating element according to claim 26, wherein the second medium or the third medium is any one of TiO_2, Nb_2O_5, Ta_2O_5, SiN, SiO_2, SiO, ZrO_2 and Sb_2O_3.

29. (Original) The diffraction grating element according to claim 15, wherein the second medium and the third medium are in contact with each other.

30. (Original) A diffraction grating element, comprising:

given first-fourth planes disposed parallel with each other in order, a first medium (index of refraction n_1) provided at the outer side than the first plane being in contact with the first plane,

a second medium (index of refraction n_2) and a third medium (index of refraction n_3, $n_3<n_2$) disposed alternately in a predetermined direction parallel with the first plane between the second plane and the third plane being in contact with the second plane and the third plane to constitute a diffraction grating,

a fourth medium (index of refraction n_4) provided at the outer side than the fourth plane being in contact with the fourth plane,

a fifth medium (average index of refraction n_5) provided between the first plane and the second plane being in contact with the first plane and the second plane, and

a sixth medium (average index of refraction n_6) provided between the third plane and the fourth plane being in contact with the third plane and the fourth plane, wherein

given that an average index of refraction between the second plane and the third plane is n_{av}, the average index of refraction n_5 of the fifth medium satisfies a relational expression of "$n_1<n_5<n_{av}$" or "$n_{av}<n_5<n_1$", and the average index of refraction n_6 of the sixth medium satisfies a relational expression of "$n_4<n_6<n_{av}$" or "$n_{av}<n_6<n_4$".

31. (Original) The diffraction grating element according to claim 30, wherein the average index of refraction n_5 of the fifth medium satisfies a relational expression of "$(n_1n_{av})^{1/2}-0.2<n_5<(n_1n_{av})^{1/2}+0.2$".

32. (Original) The diffraction grating element according to claim 31, wherein the average index of refraction n_6 of the sixth medium satisfies a relational expression of "$(n_4n_{av})^{1/2}-0.2<n_6<(n_4n_{av})^{1/2}+0.2$".

33. (Original) The diffraction grating element according to claim 30, wherein, given that the period of the diffraction grating is Λ; the thickness of the fifth medium with respect to a direction perpendicular to the first plane is h_5; and light of a wavelength λ enters the diffraction grating, a wavelength λ of light that satisfies a relational expression of "$\lambda\Lambda/4(4n_5^2\Lambda^2-\lambda^2)^{1/2}<h_5<3\lambda\Lambda/4(4n_5^2\Lambda^2-\lambda^2)^{1/2}$" is present in a waveband of 1.26μm-1.675μm.

34. (Original) The diffraction grating element according to claim 33, wherein, given that the period of the diffraction grating is Λ; the thickness of the sixth medium with respect to a direction perpendicular to the first plane is h_6; and light of a wavelength λ enters the diffraction grating, the wavelength λ of light that satisfies a relational expression of "$\lambda\Lambda/4(4n_6^2\Lambda^2-\lambda^2)^{1/2}<h_6<3\lambda\Lambda/4(4n_6^2\Lambda^2-\lambda^2)^{1/2}$" is present in a waveband of 1.26μm-1.675μm.

35. (Original) The diffraction grating element according to claim 30, wherein the fifth medium includes a plurality of media disposed alternately in the predetermined direction.

36. (Original) The diffraction grating element according to claim 35, wherein the

sixth medium is made of a plurality of media disposed alternately in the predetermined direction.

37. (Original) The diffraction grating element according to claim 30, wherein a wavelength of light in which each diffraction efficiency of TE polarized light and TM polarized light is 90% or more, is present.

38. (Original) The diffraction grating element according to claim 30, wherein a wavelength of light in which the difference of the diffraction efficiency between TE polarized light and TM polarized light is 5% or less is present.

39. (Original) The diffraction grating element according to claim 30, wherein the difference between the index of refraction n_2 of the second medium and the index of refraction n_3 of the third medium is 0.7 or more.

40. (Original) The diffraction grating element according to claim 39, wherein the second medium is any one of TiO_2, Ta_2O_5 and Nb_2O_5, and the third medium is a gas.

41. (Original) The diffraction grating element according to claim 30, wherein the second medium or the third medium is made of a predetermined material of which index of refraction changes by an irradiation of energy beam.

42. (Original) The diffraction grating element according to claim 41, wherein the predetermined material is a diamond-like carbon.

43. (Original) The diffraction grating element according to claim 30, wherein the first medium, the fourth medium, the fifth medium or the sixth medium is made of a predetermined material of which etching rate is slower than that of the second medium or the third medium.

44. (Original) The diffraction grating element according to claim 43, wherein the

predetermined material is any one of Al_2O_3, MgO, Nd_2O_3 and a fluorinated compound.

45. (Original) The diffraction grating element according to claim 43, wherein the second medium or the third medium is any one of TiO_2, Nb_2O_5, Ta_2O_5, SiN, SiO_2, SiO, ZrO_2 and Sb_2O_3.

46. (Original) The diffraction grating element according to claim 30, wherein the second medium and the third medium are in contact with each other.

47. (Currently Amended) A diffraction grating element, comprising:

given first-third planes disposed parallel with each other in order, a first medium (index of refraction n_1) provided at the outer side than the first plane being in contact with the first plane,

a second medium (index of refraction n_2) and a third medium (index of refraction n_3, $n_3<n_2$) disposed alternately in a predetermined direction parallel with the first plane between the second plane and the third plane being in contact with the second plane and the third plane to constitute a diffraction grating,

a fourth medium (index of refraction n_4) provided at the outer side than the third plane being in contact with the third plane, and

a fifth medium (average index of refraction n_5) provided between the first plane and the second plane being in contact with the first plane and the second plane, wherein

given that the average index of refraction between the [[first]] second plane and the ~~second~~ third plane is n_{av}, the average index of refraction n_5 of the fifth medium satisfies a relational expression of "$n_1<n_5<n_{av}$" or "$n_{av}<n_5<n_1$".

48. (Original) The diffraction grating element according to claim 47, wherein the average index of refraction n_5 of the fifth medium satisfies a relational expression of "$(n_1n_{av})^{1/2}-0.2<n_5<(n_1n_{av})^{1/2}+0.2$".

49. (Original) The diffraction grating element according to claim 47, wherein,

given that the period of the diffraction grating is Λ; the thickness of the fifth medium with respect to a direction perpendicular to the first plane is h_5; and light of a wavelength λ enters the diffraction grating, the wavelength λ of light that satisfies a relational expression of "$\lambda\Lambda/4(4n_5^2\Lambda^2-\lambda^2)^{1/2}<h_5<3\lambda\Lambda/4(4n_5^2\Lambda^2-\lambda^2)^{1/2}$" is present in a waveband of 1.26μm-1.675μm.

50. (Original) The diffraction grating element according to claim 47, wherein the fifth medium is made of a plurality of media disposed alternately in the predetermined direction.

51. (Original) The diffraction grating element according to claim 47, wherein each index of refraction n_2-n_4 of the second medium, the third medium and the fourth medium satisfies a relational expression of "$n_3<n_4<n_2$".

52. (Original) The diffraction grating element according to claim 51, wherein the index of refraction n_4 of the fourth medium satisfies a relational expression of "n_{av}-$0.2\leq n_4\leq n_{av}+0.2$".

53. (Original) The diffraction grating element according to claim 51, wherein the thickness of the fourth medium with respect to a direction perpendicular to the first plane is 5μm or more.

54. (Original) The diffraction grating element according to claim 47, wherein a wavelength of the light in which the diffraction efficiency of the TE polarized light and the TM polarized light is 90% or more, respectively, is present.

55. (Original) The diffraction grating element according to claim 47, wherein a wavelength of light in which the difference of the diffraction efficiency between TE polarized light and TM polarized light is 5% or less is present.

56. (Original) The diffraction grating element according to claim 47, wherein the difference between the index of refraction n_2 of the second medium and the index of refraction n_3

of the third medium is 0.7 or more.

57. (Original) The diffraction grating element according to claim 56, wherein the second medium is any one of TiO_2, Ta_2O_5 and Nb_2O_5, and the third medium is a gaseous matter.

58. (Original) The diffraction grating element according to claim 47, wherein the second medium or the third medium is made of a predetermined material of which index of refraction changes by an irradiation of energy beam.

59. (Original) The diffraction grating element according to claim 58, wherein the predetermined material is a diamond-like carbon.

60. (Original) The diffraction grating element according to claim 47, wherein the first medium, the fourth medium or the fifth medium is made of a predetermined material of which etching rate is slower than that of the second medium or the third medium.

61. (Original) The diffraction grating element according to claim 60, wherein the predetermined material is any one of Al_2O_3, MgO, Nd_2O_3 and a fluorinated compound.

62. (Original) The diffraction grating element according to claim 60, wherein the second medium or the third medium is any one of TiO_2, Nb_2O_5, Ta_2O_5, SiN, SiO_2, SiO, ZrO_2 and Sb_2O_3.

63. (Original) The diffraction grating element according to claim 47, wherein the second medium and the third medium are in contact with each other.

64. (Original) A diffraction grating element, comprising:

a base plate,

a first reflection-inhibiting portion provided on the base plate,

a diffraction grating portion provided on the first reflection-inhibiting portion, and

a second reflection-inhibiting portion provided on the diffraction grating portion, wherein the second reflection-inhibiting portion is in contact with a first medium,

in the diffraction grating portion, a second medium and a third medium are disposed alternately in a predetermined direction parallel with the base plate to constitute a diffraction grating,

in a waveband of 1.26μm-1.675μm, a wavelength of which reflectance is 10% or less is present.

65. (Original) The diffraction grating element according to claim 64, wherein, given that a direction where the base plate, the first reflection-inhibiting portion, the diffraction grating portion, and the second reflection-inhibiting portion are aligned in order is the z-direction, and the predetermined direction is the x-direction,

given that a refraction distribution is n (x, z) and a period of the diffraction grating is Λ, and

given that an average index of refraction n_{av} (z)is

$$n_{av}(z) = \sqrt{\frac{\int_0^{\Lambda} n^2(x,z)dx}{\Lambda}},$$

a modulation of the index of refraction Δn (z) is

$$\Delta n(z) = \sqrt{\frac{\Lambda \int_0^{\Lambda} \left\{n^2(x,z) - n^2{}_{av}(z)\right\}^2 dx}{\left\{\int_0^{\Lambda} n(x,z)dx\right\}^2}}, \text{ and}$$

the diffraction capacity P (z1, z2) from a position z1 to a position z2 in the z-direction is

$$P(z1,z2) = \int_{z1}^{z2} \Delta n(z)dz,$$

the diffraction capacity of the diffraction grating portion is larger than 50% of the entire diffraction capacity of the diffraction grating portion, the first reflection-inhibiting portion and the second reflection-inhibiting portion.

66. (Original) The diffraction grating element according to claim 65, wherein the modulation of the index of refraction of the diffraction grating portion is larger than the modulation of the index of refraction of the first reflection-inhibiting portion and the second reflection-inhibiting portion.

67. (Original) The diffraction grating element according to claim 64, wherein the maximum refraction of the diffraction grating portion is larger than the index of refraction of the base plate and the first medium.

68. (Original) The diffraction grating element according to claim 64, wherein the period of the diffraction grating is 1.675μm or less.

69. (Original) The diffraction grating element according to claim 64, wherein a wavelength of the light in which the diffraction efficiency of the TE polarized light and the TM polarized light is 90% or more, respectively, is present.

70. (Original) The diffraction grating element according to claim 64, wherein a wavelength of the light in which the difference of the diffraction efficiency between the TE polarized light and the TM polarized light is 5% or less is present.

71. (Original) The diffraction grating element according to claim 64, wherein the difference between the index of refraction n_2 of the second medium and the index of refraction n_3 of the third medium is 0.7 or more.

72. (Original) The diffraction grating element according to claim 71, wherein the second medium is any of TiO_2, Ta_2O_5 and Nb_2O_5, and the third medium is a gas.

73. (Original) The diffraction grating element according to claim 64, wherein the second medium or the third medium is made of a predetermined material of which index of

refraction changes by an irradiation of energy beam.

74. The diffraction grating element according to claim 73, wherein the predetermined material is a diamond-like carbon.

75. (Original) The diffraction grating element according to claim 64, wherein the second medium and the third medium are in contact with each other.

76. (Original) A production method of the diffraction grating element according to any one of claims 1, 15, 30, 47 and 64, comprising the steps of:

forming a layer made of a predetermined material of which index of refraction changes by an irradiation of energy beam; and

irradiating an energy beam onto the layer with a spatial strength modulation pattern to form a diffraction grating in which the second medium and the third medium with an index of refraction different from each other are disposed alternately in the layer.

77. (Original) A method of fabricating the diffraction grating element according to any one of claims 1, 15, 30, 47 and 64, comprising the steps of:

forming a layer made of a predetermined material; and

performing an etching on the layer with a predetermined spatial pattern to form a diffraction grating in which the second medium and the third medium with an index of refraction different from each other are disposed alternately in the layer.

78. (Original) A designing method of a diffraction grating element having a diffraction grating portion of which index of refraction changes periodically in a predetermined direction and a reflection-inhibiting portion on at least one of the top and the bottom of the diffraction grating portion, comprising the steps of:

determining so that each of the diffraction grating portion and the reflection-inhibiting portion is formed with a film having an average index of refraction due to the media included therein and setting the phase change of light at the diffraction grating portion to 90°, and

deriving refraction distribution of the diffraction grating element so that the reflectance is 10% or less at a desired wavelength.